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Evaluation of Ignition Mechanisms in Selected Nonmetallic Materials

The fire hazard associated with concentrated oxygen atmospheres in enclosures has been recognized for many years. Spacecraft, deep submergence vehicles, and high altitude simulators used in medical research often use such atmospheres. In spite of attempts to provide a greater margin of safety through more stringent material selection procedures, fires have occurred in chambers having high oxygen partial pressures. These incidents point up the need for better understanding of the ignition and flame propagation process for solid materials which will lead to advanced and improved materials screening and test methods.

To this end, a test program was initiated to evaluate ignition mechanisms in selected nonmetallic materials usually found in the structures and fixtures of spacecraft, etc. The principal focus of attention in the study of ignition mechanisms has been associated with two types of ignition sources, thermal and electrical. Three separate phenomena may be considered in discussing the problem.

The first phenomenon is closely related to the process variously called thermal ignition, autogeneous ignition, or spontaneous ignition. Heat acts as the energy source for ignition and in most cases also causes the formation of gases by vaporization, sublimation, or decomposition. The ASTM autogeneous ignition apparatus and various modifications of it provide tests for this type of ignition.

The second process involves the ignition of a flammable vapor by means of a spark or glowing surface. The source of flammable vapor may be vaporization of a volatile combustible or, for low volatility materials, exposure to heat may (as in the thermal ignition process) generate flammable material by vaporization,

sublimation, or decomposition. The flash point and fire point tests are examples of standard procedures which provide this kind of information on materials. It should be emphasized that tests for these two processes are quite different. While heat may be the source of combustible vapor in both cases, in the flash point test an ignition source exists, such as a spark, flame, or glowing surface. In thermal ignition tests, a critical temperature is sought, below which no ignition occurs. Thermal ignition is thus a measure of the minimum energy required for ignition; flash point is a measure of the heat necessary to provide a combustible mixture.

The third process involves ignition by a spark or arc where the arc is the source of energy producing the combustible vapor as well as the ignition source. Generally the energy in an arc is adequate to accomplish both purposes but the transfer of energy is very inefficient. In any event, this process simulates the events occurring when a circuit is overloaded or when a short circuit exists.

In order to scan quickly a variety of configurations and to investigate all three mechanisms, several different ignition test configurations were used. Each configuration was selected to provide data in a given environment.

Note:

Inquiries concerning this test program may be directed to:

Technology Utilization Officer
Manned Spacecraft Center
Houston, Texas 77058
Reference: B68-10167

(continued overleaf)

Patent status:

No patent action is contemplated by NASA.

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